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UNIVERSITY OF ALBERTA

DRGs, SEVERITY OF ILLNESS AND NURSING COSTS

by

DEVIDAS MENON

A THESIS

SUBMITTED TO THE DEPARTMENT OF HEALTH SERVICES ADMINISTRATION
AND COMMUNITY MEDICINE IN PARTIAL FULFILMENT OF THE
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AND COMMUNITY MEDICINE

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FACULTY OF GRADUATE STUDIES AND RESEARCH

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ABSTRACT

This study examines the relationship between a medically-based measure of severity - the Medis Groups severity of illness - and Costs of Nursing in a group of 177 admissions to two British Columbia hospitals. These admissions were in 7 DRGs. The variations in nursing costs between DRGs, within DRGs and between hospitals were studied.

Substantial variations between the DRGs have been demonstrated in both per-admission and per-diem costs. In RJH, per-admission costs range from $365.69 to $2,747.30 and in VGH, from $280.32 to $2,277.75. Similarly, the corresponding ranges for per-diem costs are $68.43 to $217.19 (RJH) and $59.95 to $121.97 (VGH). These variations are driven at least partially by medical severity of illness. As severity increases with DRG, nursing costs tend to increase as well. In some DRGs, there are statistically significant cost differences between severity levels. It is also shown that when patients within DRG are subgrouped by severity, the resulting groups are more homogenous with respect to nursing costs. However, medical severity does not account fully for nursing costs.

Differences in nursing costs for the two study hospitals are demonstrated. These differences appear to vary with severity and DRG. There is no consistent difference in average costs or severity between the two hospitals.

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CHAPTER 1

INTRODUCTION AND STUDY OBJECTIVES

1.1 General Background

Health care costs, especially in the United States have been consuming an increasing proportion of the gross national product. The largest single factor in health care costs has been the cost of hospital care. As a result, the federal government in the United States began considering various ways of trying to curb hospital costs some years ago. This culminated, in 1983, with the instituting of the Prospective Payment System (PPS). Under this system, reimbursement of hospitals treating Medicare patients was based on a system of Diagnosis-Related Groups (DRGs). A DRG is a category based principally on a medical diagnosis, and every patient admitted into a hospital is on this basis assigned to a DRG. For each Medicare patient in a DRG, the Health Care Financing Administration (HCFA) has determined the amount of reimbursement the hospital is entitled to for the hospitalisation.

Clearly, not all patients are identical. The treatment of individuals in a given DRG may vary, due to a number of reasons. The course of the disease, for example, may differ

from patient to patient. One patient may be sicker than another, one patient may deteriorate and have to be transferred to an ICU, one physician may treat the patient differently from another. As a result of these and other reasons, the "single, fixed payment per DRG" system will mean that for some patients the hospital will be overpaid, while for others, its costs may not be met. The rationale behind the PPS is that such over-and under-expenditures (or variances in the costs from DRG prices) will average out over an individual hospital's case-mix.

When the DRG system was established, prices for individual DRGs were based mainly on projected lengths-of-stay (LOS). In the case of nursing, for example, the contribution to DRG price was calculated assuming a per-diem cost for all routine services (which included nursing). Variations in nursing intensity (ie. the amount and type of nursing care required for a specific patient) were not considered. DRGs have therefore come under considerable criticism, a major one being that they are based on a medical model, and thus they fail to allow explicitly for nursing intensity differences across diagnostic groups.

In addition to the criticism that DRGs assume similar nursing needs for patients in different DRGs, another objection is that they do not take into account that nursing needs for different patients in the same DRG may be different. The DRG system assumes that all patients in one DRG are (relatively) similar as far as hospital resource consumption - including nursing resources- is concerned. In reality, patients in a single diagnostic category may differ in "severity" of the disease or illness, or could have differing characteristics or needs, and could require different nursing intensities. Some of the variance in actual costs (as compared to DRG prices) of hospitalisation could therefore arise from differences in severity.

The format of this thesis is as follows. Following a definition of terms in Section 2 of this chapter, the study questions are stated in Section 3 . Chapter 2 contains a literature review. The literature that discusses potential problems with the PPS and DRGs, in particular the ability of DRGs to produce homogeneous groups of patients is reviewed first. There is next a review of literature examining nursing intensity as a cause of heteropheitis in DRGs. Similarly the effects of medical severity within and between DRGs are considered in Chapter 2.3. In the last section, a review of medical severity systems in use is presented.

The data that forms the basis of this study and the methods of data analysis are presented in Chapter 3. The patient population is described and nursing costs, as identified for this study, are detailed. Chapter 3 also contains a more detailed description of MedisGroups, the severity of illness measurement system employed. Chapter 4 contains a description of the results of the study, as far as the three questions which it attempts to address are concerned. Cost variations between DRGs, within DRGs, and between hospitals are presented.

In Chapter 5, the relevance of the results obtained is discussed, as well as the limitations of the study. Finally, Chapter 6 contains a short summary and conclusions.

1.2 Terminology

For this thesis, severity is taken to represent a measure that is primarily clinically or medically oriented i.e. one that uses medical indicators, such as blood pressures, infection, physical examination findings and results of laboratory or diagnostic imaging tests. This is to be contrasted with nursing intensity or acuity which is determined by a patient's need, requirements, dependency, mobility, etc. Although severity of illness systems and nursing intensity systems are similar in that they are both classification systems, the

basis for the classification and the reasons for classification are different.

1.3 Objectives of the Study

Three questions are addressed in this study. They relate to variations in the costs of providing nursing care to patients in different diagnostic categories and illness severities in two different hospitals.

> Question 1: What, if any, are the variations in the costs of nursing care of patients in different DRGs?
>
> Question 2: What are the variations in nursing costs within DRGs, and how do these depend on severity of illness?
>
> Question 3: How do nursing costs vary between the two hospitals , for severity-matched patient groups in specific DRGs?

Question 1 addresses across-DRG variations in cost. This is important because the PPS assumes that nursing costs are the same across all DRGs. If in actual practice, nursing intensities and so nursing costs vary from DRG to DRG, then

the reimbursement to hospitals will not be fair. The actual payment will be less than the costs for some DRGs and more for other DRGs.

Within-DRG variations are addressed in Question 2. If there are significant differences in the costs of nursing care of patients in the same DRG, again the DRG system will fail as a method of fair reimbursement to hospitals. Some hospitals may have systematically more high cost cases (within a DRG) than others, and will therefore require more resources to treat and hospitalise them. Inter-hospital comparisons of costs for hospitalisation of patients in the same DRG will have to take these within-DRG variations into account. If severity of illness is one reason for these variations, severity-adjusted DRGs (ie when a DRG is subgrouped by severity) may be more meaningful in studying nursing costs.

The data available for this project makes it possible to address Question 3. Like severity of illness, the hospital in which the patient is treated could be a factor in within-DRG variations in cost. As well, having data from more than one hospital makes it possible to test the validity of using severity to sub-categorise patients in specific DRGs.

CHAPTER 2

A REVIEW OF THE LITERATURE

The following is a review of recent literature of the DRG system and inadequacies with it, nursing intensity variations and DRGs, DRGs and medical severity of illness systems and a brief review of medical severity systems.

2.1 DRGS and the Prospective Payment System (PPS)

In an attempt to control escalating hospital costs in the United States, the Prospective Payment System (PPS) was instituted in the fall of 1983. In this system, hospitals treating medicare patients are reimbursed based on diagnosis-related groups. DRGs are an attempt to classify patients of similar clinical type on the basis of a small number of characteristics and assumes that this classification scheme can be translated into system of per-admission costs. Though this is a medical model, it assumes that such a system is an accurate way of predicting hospital resource use, and that it will result in fair reimbursement to hospitals (Fetter RB, Shin YS, Freeman JL, Averill RF and Thompson JC, 1980).

DRGs are based on Major Diagnostic Categories (MDC) representing the major body organs. Each MDC is divided into smaller categories based on diagnosis, complications,

procedures performed, patient age/sex and status at discharge. There are 467 DRGs within the 23 MDCs. The DRGs are categorised with the goal of minimising variance in length of stays (LOS) of patients within each DRG. As such, DRGs are intended to produce homogeneous groups of patients based on LOS which take into account factors such as diagnosis, patient age/sex, procedures performed, etc.

Since the institution of the PPS, many authors have criticized the DRG classification scheme, as far as producing such homogeneous groups and ensuring fair reimbursement of hospitals. A number of sources have been reported as being responsible. Vladeck (1984) recognised that there are inadequacies in data from patient records that are used to assign DRGs. The author reported that the system did not accommodate for variation in intensity, and as a result, there are inhomogeneities and in some cases, outliers.

The fact that the PPS is based on a medical model has also been cited as a weakness of DRGs. Although the 467 categories are meaningful in that they group patients together who have similar medical characteristics, when diagnostic and therapeutic regimes for those patients are considered, they exhibit considerable inhomogeneity. Hornbrook (1982) reported that these inhomogeneities made the system inadequate either

for quality assessment or for internal management purposes. The International disease coding nomenclature (ICD-9-CM) used in DRG classification has itself been cited as the big reason for problems with the PPS (Mullin RL, 1985). This has been echoed by Iezzoni and Moskowitz who state that because of the coding system, "DRGs have failed to create clinically mutually exclusive groups because of inattention to diagnostic semantics" (Iezzoni LI and Moskowitz MA, 1986).

A number of authors have identified the failure to incorporate a patient's degree of illness more completely into DRGs as the source of inhomogeneities (Gortman PM and Lowenstein S, 1984; Mendenhalls, 1984; Kreitzer SL, Loebner ES and Roveti GC, 1982). Specific reports on how these inhomogeneities result in DRGs from a resource utilisation point-of-view are discussed in the next two sections.

2.2 DRGs and nursing intensity

The amounts and types of nursing care that are required during the course of hospitalisation of patients vary from patient to patient within each DRG. This is not reflected in the way the DRG system was developed. It is assumed in this system that the amount of nursing provided per patient per day is not only the same for all patients within a DRG, but also across all

DRGs (Petengill F and Vertrees J, 1982). Nursing intensity is not incorporated within a DRG, and nursing resource use is separated only in special care units (Shaffer F, 1984; Thompson J, 1985). The nursing literature reflects the result of this - DRGs are not directly related to nursing workloads, and so are not homogeneous with respect to nursing costs (Giovannetti P, 1985).

A number of studies have looked at nursing resource consumption within DRGs as well as across DRGs. In general, these studies have shown significant variances in nursing intensity both within and across DRGs. Since nursing costs are an important part of total hospital costs, part of the variance in total costs will arise from this nursing component.

A study has been conducted with nearly 25000 patients at Strong Memorial Hospital with over 210,000 patient days represented (Sovie MD, Tarcinale M, Vanputte A and Stunden AE, 1985). Part of the study was to examine any relationship between nursing workloads (using a modified Medicus system) and DRGs. The authors demonstrated large ranges and coefficients of varition for nursing hours, reflecting the variability of nursing needs of individual patients within DRGs.

A study of 89 patients in 4 DRGs was conducted at Stanford University Hospital, one of whose objectives was to look at the range in nursing intensity and labour costs. Wide variances were demonstrated both in times and in dollars across DRGs. Between DRGs, for example, labour hours ranged from a mean of 68 hours to 109 hours, and costs from $1109 to $1778 (Mitchell M, Miller J, Welches L and Walker DD, 1984).

Halloran and Halloran (1985) examined how nursing intensity - and as a consequence, hospital costs - varied, by studying over 2500 patients in 31 DRGs. The Medicus system was used to estimate the time needed for 8 hour shifts. A point system was used which is related to nursing time. The study showed that between DRGs, the number of points ranged from 10.8 to 46.1. The authors state that 1 point represented approximately 5 minutes of nursing time.

Widely ranging nursing costs were also demonstrated in a study of 716 admissions in 13 DRGs in a 158 bed San Diego hospital. Actual nursing costs were used. Nursing costs ranged from 6.1% to 15.5% of DRG reimbursement, and the average nursing costs varied from $152.00 to $976.00. Predicted costs did not always go up as patients requirements for care increased. Widely ranging nursing

costs were apparent (Fosbinder D, 1986).

Within - DRG variations have been demonstrated in other studies as well. In one, 52 patients in 2 DRGs demonstrated up to 69% variance in LOS , with ranges of $98 to $784 in charges in one DRG and of $ 148 to $ 4282 in the other (Reschak GLC, Biordi D, Holm K and Santucci N, 1985). A sample of 240 patients in 5 DRGs was studied by Mowry and Korpman (1985) to look at nursing resource use within DRGs. Although two of the DRGs showed little variations in nursing costs per day (ranging from $42 to $59 and $44 to $53) three did (ranging from $42 to $90, $41 to $179 and $42 to $223). This per diem method used by DRG is clearly not in agreement with allocating of nursing costs by intensity (Mowry MM and Korpman RA, 1985).

Finally, in a retrospective study over a year, using a database of nearly 30,000 patients in 160 DRGs, Trofino showed wide degrees of variability in nursing care hours and length-of-stay within DRGs. The author suggested that the main factor driving length-of-stay was physician practice (Trofino J, 1989).

Such between-group variations have been reported not just for DRGs, but for the Canadian Case Mix Groups system as well. These are similar to DRGs in that they are a <u>diagnostic</u>

classification. In a recent study, O'Brien-Pallas (1987) showed that there were substantial differences in nursing intensity for patients in 5 different CMGs. This was shown to be the case using three different patient classification systems.

2.3 DRGs and Medical Severity

The influence of severity of illness on homogeneity of patients in specific DRGs has been studied by various authors. Although the DRG system attempts to incorporate severity by using adjustments for comorbidity and complications, as suggested by Mendenhall, these are not fairly dealt with (Mendenhall S, 1984). Jones (1984) has pointed out the importance of severity, since it relates to prognosis, use of resources, variations in treatment, support services and length of stay.

One of the earlier attempts to include severity of illness was that of Susan Horn and colleagues (Horn SD, Sharkey PD and Bertram DS, 1983). In a study of six disease categories- four medical and two surgical- the authors showed that DRG data exhibited considerable inhomogeneities in a number of variables. The effect of adding the dimension of severity into the classification scheme on homogeneity was assessed in three

ways: reduction in variance (RIV), change in coefficient of variation (CV) and by performing an analysis of variance (ANOVA). There were performed on LOS and routine, laboratory, radiology and total changes.

RIV is a measure of variability that is removed by dividing a data set into subgroups; so the "ideal" valve of RIV is 100%. CV is the ratio of standard deviation to the mean of a data set. The smaller CV, the more homogeneous the data set. ANOVA compares difference between means in two groups with the variance within each group (Sokal RC and Rohlf FJ, 1969).

All three measures of homogeneity for the conditions studied by Horn et al showed widespread heterogeneities within DRGs. When all patients in cerebrovascular DRGs were subgrouped by DRG, the RIV achieved was only 10% to 22%.

In retrospective chart review of randomly selected records in 4 DRGs, Horn's severity index was modified slightly to obtain what the authors term an "acuity" measure. The authors concluded that nursing resource use - as measured by nursing hours and cost - fluctuates widely even within DRGs, and with this acuity measure as well (Grohar ME, Myers J and McSweeney M, 1986). They further stated that "patient classification systems using medical morbidity to arrive at an approximation

of acuity do not predict nursing resource use".

A study of 11,000 patients in combined DRGs comparing nursing time by DRG with Horn's severity index was reported by Marks (1987). The author found a significant, but moderately weak, positive correlation between the severity index and mean required nursing hours. Per-diem nursing hours increased consistently from average of 9.774 for low severity to 19.794 for high severity.

In another study, 351 patients in 4 wards included. Nursing workload was measured by using an in-house developed patient acuity scale (PAS) and severity by using Horn's index. The major finding was taht workload depended on severity, LOS and age. The workload went from about 1.5 (PAS units) for the low severity group, to 1.8 (medium severity) and 3.0 (high severity). The PAS units go from 1 to 5 (Mion LC, McLaren CE and Frengley JD, 1988).

A final study at nursing and medical severity is worthy of note. The study was partly to examine the variation of nursing time and costs, based on an acuity system developed by the Veterans' Administration, within 2 DRG's. The authors demonstrated wide variances in nursing time and costs and LOS. They concluded that part of these variations were due to actual

severity differences or perceived differences according to the classifier. No proprietary severity measure was used (Rosenbaum HL, Willert TM, Kelly EA, Grey JF and McDonald BR, 1988).

Other costs have been examined as well. For Laboratory services it has been shown that illness severity is an important determinant of costs (Stefanu C, Newman RG, Pate ML, Chassie MB and Anderson RJ, 1984). In this study, 57 patients were classified into 6 severity levels - no DRG classification was used. Both numbers of tests and their cost were shown to increase significantly with severity from 0.97 to 2.92 procedures and $ 17.34 to $ 42.24 respectively.

Specific disease conditions and the impact of varying severity levels within them have been studied in this context as well. Over 4300 patients classified into 8 DRGS were included in a 1986 study. The study attempted to identify dimensions other than LOS or charge per case which are relevant to case mix (Vertrees J and Manton KG, 1986). The author's analysis showed that severity was one of five such additional dimensions, the others being prognosis, interaction of multiple diseases, admission status and treatment strategy. Girotti and Brown (1986) undertook a study of 67 ICU patients at Kingston General Hospital and, based on 6 diagnostic criteria, divided them into two severity groups. The means

and standard deviations in resource measures showed significant differences: LOS - 7.5 days ± 8.4 days in the more severe compared to 3.2 days ± 2.2 days in the less severe group; total costs - $ 7274 ± $ 7881 to $ 1786 ± $ 2255, and costs per patient day - $ 1076 ± $ 167 to $ 879 ± $ 75. Based on their analysis, the authors concluded that patient severity was a critical factor in explaining or predicting resource utilisation.

McMahon and Newbold (1986) concluded, on the basis of a study of intra-DRG variability in patients admitted to 4 Maryland hospitals that a number of factors were at play. Severity was one; however, physician practice was also identified as one cause of variance. In another study, focusing on a single DRG (DRG 87), Hughes, Lichtenstein, Magno and Fetter (1989) demonstrated that with complexity of illness, more procedures were required for patients with respiratory failure and pulmonary edema. Adding this information on procedures to diagnostic information, concluded the authors, yielded more homogeneous patient groups. In another specific patient group - those requiring coronary angioplasty - a study of 117 patients showed that both LOS measures and costs increased with severity defined either by a functional capacity classification, or by type of admission (elective/non-elective). (Barbash CI, Babkin MT, Kane NM and Baim DS, 1986).

For ICU patients, similar results have been reported. Generally speaking, such studies have concluded that the lack of adequate incorporation of severity causes the DRG application to ICU patients to be inappropriate (Bekes C, Fleming S and Scott WE, 1988; Rapoport J, Teres D, Lemeshow S, Avrunin JS and Haber R, 1990).

Since the introduction of the DRG system and the PPS based on it, a general consensus has developed in the literature that it creates inappropriate incentives for hospitals, due in part to the fact that medical severity is inadequately coded into the DRGs. It was the need for a case-mix system that was more sensitive to illness severity that first created the interest in severity measures (Aronow DB, 1988). However, more recently, the recognition that severity measures may have wider application than for reimbursement, e.g. in analysing individual patient's hospital resource consumption patterns, or in obtaining accurate physician practice profiles, or in utilisation review, has led to increased interest in this area (Horn SD, 1986; Arbitman DB, 1989).

Body Systems (BS): This system was developed by the Commission on Professional and Hospital Activities (CPHA) and is non-proprietary. Essentially, it assumes that severity - in terms of complexity of clinical management and use of resources - increases with the number of organ systems involved in the disease. A count of MDCs (Body Systems Count) is done to obtain an integer representative of the severity (Mendenhall, 1984). BS is the simplest system of severity measures to apply, but also the crudest. There has been no published evaluation of BS, for resource utilisation or for explaining DRG variances.

Disease Staging (DS): This concept has its basis in clinical oncology, in which there are discrete stages in the process of neoplastic diseases which reflect severity (Gonnella JS, Hornbrook MD and Louis DZ, 1984). Diseases are divided into four stages of increasing levels of severity, from Stage I (conditions with no complications or problems of minimal severity), Stage II (single organ or system, increased risk of complications), Stage III (multiple site involvement, etc.) and Stage IV (death). DS has been criticized as being unable to predict resource consumption (Coffey RM and Goldfarb MG,1986).

Patient Management Categories (PMC): This is a methodology developed by W. Young originally with funding from the Health Care Financing Administration as an alternative to DRGs (Young WW, Swinkola RB and Zorn DM, 1982; Young WW, 1984). PMCs were designed to identify clinically specific patient types, each type requiring a distinct diagnostic and treatment strategy.

The system attempts to categorize patients who need a common set of diagnostic and therapeutic procedures. The principal diagnosis is ignored. There is little in the literature that discusses variance in charges. Using 1985 data from Maryland, one report has PMCs accounting for 24% of the variation in charges, compared to 21% using DRGs (Pass T, 1987). PMCs have been criticized as being definitions of "appropriate" treatment regimes based on a small number of practitioners on panels (Conklin JE, Lieberman JV, Barnes CA and Louis DZ, 1984).

Computerised Severity Index (CSI): CSI is the successor to the manual Severity of Illness Index of Susan Horn's group (Horn SD, Chachich B and Clopton C, 1983). Patient severity is assigned according to clinical signs recorded during hospitalisation. Each ICD-9-CM diagnostic code has an additional integer added, representing severity (Horn, 1986). Although the original index of severity has been well

evaluated, particularly by Horn and colleagues, little evaluation of the computerised approach, mainly because of its newness, has been done (Aronow, 1988).

APACHE II: APACHE stands for Acute Physiology and Chronic Health Evaluation. APACHE II is a revised version of a system developed in the 1970's at George Washington University Medical Centre for classifying ICU patients (Knaus WA, Zimmerman JE, Wagner DP, Draper EA and Lawrence DE, 1981; Wagner DP and Draper EA, 1984). In this system, twelve commonly measured physiological variables are included. A patient can be assigned up to 72 total points, higher scores indicating greater severity. To date, no research on the applicability of APACHE II to general hospital (non-ICU) admissions has been done.

MedisGroups (MG): This system uses objective, key clinical findings from a patient record to define severity. It is a proprietary, clinically-based management information system based on a patient's condition on admission (Jones DJ, 1987). It classifies patients through analysis of key findings, such as level of consciousness, respiration, arterial blood gases, etc. (Brewster AC, Karlin BG, Hyde LA, Jacobs CM, Bradbury RC and Chae YM, 1985). On the basis of about 500 of these findings, a severity of 0 (low) to 4 (high) is assigned.

The MedisGroups severity measurement system has undergone a number of assessments. Horn (1986), comparing it to her computerised Severity Index (CSI) claimed that CSI is superior in its ability to describe the severity of each disease condition as well as in categorising the overall patient severity throughout hospitalisation. In a large-scale comparison of severity systems conducted at the University of Michigan for the University Hospital Consortium, the authors concluded that no system was clearly superior to the others. However, at the time of the study, there was little access to the internal logic of MedisGroups due to proprietary reasons, and its clinical credibility was not clearly proven (Thomas JW, Ashcraft MLF and Zimmerman J, 1986). More recently, Iezzoni and Moskowitz (1988) undertook a clinical evaluation of MedisGroups, in which they concluded that although it may be useful for clinical application for quality assurance, its ability to predict hospitalisation costs was not guaranteed. Subsequently the same group studied over 54,000 patients in 28 DRGs to evaluate this specific aspect of MedisGroups. The increase in explanatory power obtained by adding severity information was not substantial. DRGs alone explained 52% of cost variations; adding severity only raised this to 55%. However, the authors showed that costs increased on the average from $ 2,744 for severity level 0 to $ 5,862 for level 4 (Iezzoni LI, Ash AS, Cobb JL and Moskowitz MA, 1988).

These are some of the systems that have been developed to define and measure severity of illness. As mentioned before, one major reason for such work on severity is the fact that although DRGs have been defined on the basis of variance-minimising algorithms, patients within a DRG do not constitute a homogeneous group - whether measured by length of stay or costs.

It is generally accepted that teaching hospitals are more expensive than community hospitals for treating the "average" case (Garber AM, Fuchs VR and Silverman JH, 1984; Relman AS, 1984). This fact has usually been attributed to the added costs of research and education. However, in a multi-hospital study, using Horn's severity of illness index, it has been shown that it may be the higher proportion of severely ill patients in academic medical centres that causes increased costs (Horn SD, Bulkley G, Sharkey PD, Chambers AF, Horn RA and Schramm CJ, 1985). The authors found significantly large differences between the hospitals in severity that could not be accounted for by the DRG classification system. Costs of operating a hospital will therefore depend upon the average severity of the patients in the hospital.

CHAPTER 3

DATA AND METHODS

3.1 Patient groups

The data for this study comes from the Royal Jubilee Hospital (RJH) and the Victoria General Hospital (VGH), hospitals of the Greater Victoria Hospital Society (GVHS) in Victoria, British Columbia. 1777 admissions are included in the study, from November 1987 to November 1988.

Seven DRGs were selected for the study, four surgical and three medical. These are:

014: Specific cerebrovascular disorders except TIA
143: Chest pain
243: Medical back problems
209: Major joint procedures
219: Lower extremity and humerus procedure excluding hip, foot, femur, age 18-69 without complications
337: Transurethral prostatectomey, without complications
468: Unrelated OR procedure

Of the 1777 admissions, 933 (53%) were admitted to the Royal Jubilee Hospital (RJH) and 844 (47%) to the Victoria General Hospital (VGH). 59% were males and 41% females. A breakdown

of the patients by DRG, sex and hospital is contained in Table 1. The DRG with the smallest volume was 219, with 91 patients, that with the largest was 243, with 434 patients. For each patient, the following data were used for this study: age, sex, DRG, MedisGroups Severity, LOS and nursing costs.

3.2 Nursing Costs

A patient-specific costing system is in place at the Greater Victoria Hospital Society (GVHS). Nursing costs are determined on a daily basis. For the purposes of this study, "nursing costs" will be taken to comprise the following:

> Direct Care: This includes hands-on care of the patient, as well as patient-specific activity that is not done in the presence of the patient. Direct care costs are obtained using the Medicus classification system. Based on the patient's care needs, a Medicus nursing acuity level is assigned daily that is then translated into costs, using known wage rates and incorporating the RN/RNA mix where necessary. Although this does not give exactly the actual costs incurred through the actual amount of care delivered, it has been validated as a measure of nursing intensity and costs (Ruman JM and Nelson DL,1987).

Direct labour adjustment: Prospective Medicus nursing target hours are based on Medicus acuity levels and the resulting nursing labour needs for a specific nursing unit for a single nursing shift. If the actual labour hours for that shift (determined from actual payroll expense figures) differ from the target hours, this variance is adjusted for. The costs, based on target hours for the entire unit are corrected to equal actual labour costs. Although this correction reconciles "target labour costs" with "actual labour costs" the reconciliation will be for the entire nursing unit, and the variance is divided among the number of patients in the unit.

Nursing benefits: These are calculated at 15% of nursing labour costs.

Management cost allocation: This is based on overall nursing management salaries.

Management benefits: These are calculated at 15% of the management cost allocation.

Materials cost allocation: This is a daily allocation for supplies (mainly gloves, dressings, etc.). This

figure is obtained by dividing total supplies expense for a nursing unit by total patient days.

Overhead cost allocation: This is also added on a daily basis for institutional overhead.

Therefore,

Nursing Costs (per day) = Direct care costs + Direct labour adjustment + Nursing benefits + Management cost allocation + Management benefits + Materials cost allocation + Overhead cost allocation

Clearly, nursing costs as defined above include everything involved in the running of a nursing unit. The argument could be made that only the "direct care" as defined above should be included. This would certainly be true if one were investigating the specific relationship between nursing intensity alone and factors like severity. However, the main focus in this study is overall nursing cost, from a management perspective, and it is more appropriate to use standard costs (Budd JM,1988).

3.3 Severity of Illness

In Section 2, a brief description of six severity measurement

systems was given. One of these - MedisGroups - is in place at GVHS. MedisGroups, which stands for Medical Illness Severity Grouping System, is a proprietary system marketed by MediQual Systems, an affiliate of a Chicago-based consulting firm, InterQual Inc. A more comprehensive description of the system follows.

MedisGroups was the result of work originating in the 1970s at St. Vincent Hospital in Massachusetts, under the direction of A. Brewster. It is an admission-oriented severity system that uses objective data, referred to as Key Clinical Findings (KCFs) from a patient record, to categorise a patient into one of five severity levels (Iezzoni LE and Moskowitz MA, 1988).

There are over 200 pieces of clinical information which could constitute KCFs. These range over a wide array of tests and procedures e.g. laboratory tests, ECGs, physical examination results, vital signs, diagnostic imaging procedures, psychological tests, neurological tests, etc. If a particular result is considered "normal", a value of 0 is assigned to the particular KCF; this in fact means the finding is not "key". For "abnormal" findings, the KCF is given a score of 1,2 or 3, 3 being most abnormal or severe. The criteria or levels used to assign this score are proprietary, and not common knowledge. The first step in determining a severity level,

therefore, is to determine which, if any, of the KCFs have scores of 1,2 or 3.

In the second step, a Severity Group (0,1,2,3 or 4) is assigned based on the number and types of KCFs - severity is 0 (least severe) if there are no key clinical findings i.e. the severity score of all KCFs is 0. At the other extreme, if 2 or more of the KCFs have severity scores of 3, the patient's overall severity is 4. This indicates the presence of organ failure. Severity of 1, 2 and 3 lie between these two limits (Brewster AC et al, 1985).

The MedisGroups system is diagnosis-independent, and as such is similar to APACHE II. However, as mentioned earlier, the latter is specific to critical care treatment. The MedisGroups Review is considered an "admission review", and is conducted within two days of admission.

3.4 Methods of Analysis

The "raw" data are patient specific nursing costs during hospitalisation. By grouping together patients in a specific DRG, an average nursing cost per admission is obtained by dividing total nursing costs for all patients in that DRG by the number of patients in that DRG. Similarly an average

nursing cost per day is calculated for each DRG. These were computed for all 7 DRGs.

To study the trends (if any) in costs within DRGs, a number of computations were performed. At first, all patients in the study were grouped by MedisGroups severity and average nursing costs for the hospitalisation calculated. Next, a one-way analysis of variance (ANOVA) was performed to compare costs between severity groups for each DRG and hospital. Finally, to determine if subgrouping patients in severity groups within a DRG resulted in a reduction of heterogeneity in nursing costs, the coefficient of variation (CV) before and after severity adjustment were calculated. This was done as follows:

First, for a given DRG XYZ, the CV of nursing costs is calculated.

$$CV\ (XYZ) = \frac{\text{Standard deviation (for XYZ)}}{\text{Mean costs (for XYZ)}}$$

CHAPTER 4

RESULTS

4.1 Variations between DRGs

A comparison of nursing costs by DRG is shown in Table 2. For each DRG, the average nursing cost per admission and the standard deviation are shown by individual hospital.

There is more than a 7-fold range in the costs of nursing care between the 7 DRGs. For RJH, the average per-admission cost ranges from $365.69 (DRG 143) to $2747.30 (DRG 014), and for VGH from $280.32 (DRG 243) to $2277.75 (DRG 014).

In Table 3, the average daily costs of nursing care by DRG are displayed. These figures are obtained by dividing mean per-admission costs by average LOS by DRG, which was also available in this study. There is almost a two-fold range in this case, from $ 66.69 for DRG 219 to $ 133.46, this high being DRG 014 once again.

4.2 Variations within DRGs

The fact that there are large variations in cost within each of the 7 DRGs in this study is apparent by the size of the standard deviations in Table 2. This is shown in a more

direct manner in Table 4. In this table, the average nursing costs per admission for all patients in the different MedisGroups severity levels are shown. The 7 DRGs have been combined. There is a clear trend in costs, at least from levels 0 to 3. As for severity level 4, the sample size was too small to draw any conclusions. Also, some patients in this category died during hospitalisation, with short lengths-of-stay. This is discussed in Section 5.2.

This data is displayed graphically in Figure 1 for the Royal Jubilee and Figure 2 for the Victoria General. The general trend displayed is also reflected when the data is separated into individual DRGs. This is presented in Tables 5-11, each of which represents one DRG.

The nursing cost-severity relationship was further examined using a single classification ANOVA. Severity was the single criterion. The results for each DRG are also on Tables 5-11.

TABLE 1

Distribution of Patients

(by DRG, sex and hospital)

DRG	Male	Female	RJH	VGH	Total
014	153	150	198	105	303
143	106	60	78	88	166
243	230	204	223	211	434
209	138	223	171	190	361
219	53	38	25	66	91
337	321	0	176	145	321
468	47	54	62	39	101
Totals	1048	729	933	844	1777

TABLE 2

Average Nursing cost per Admission (by DRG)

DRG	RJH			VGH		
	Mean	S.D.	N	Mean	S.D.	N
014	2747.30	2885.96	198	2277.75	2646.10	105
143	365.69	392.40	78	339.47	331.20	88
243	368.66	697.26	223	280.32	388.71	211
209	1179.16	991.49	171	1055.25	1704.33	190
219	393.62	263.44	25	463.83	398.05	66
337	445.39	315.65	176	528.92	224.59	145
468	1899.37	2057.86	62	1291.05	1356.96	39

TABLE 3

Average Nursing Cost per Day (by DRG)

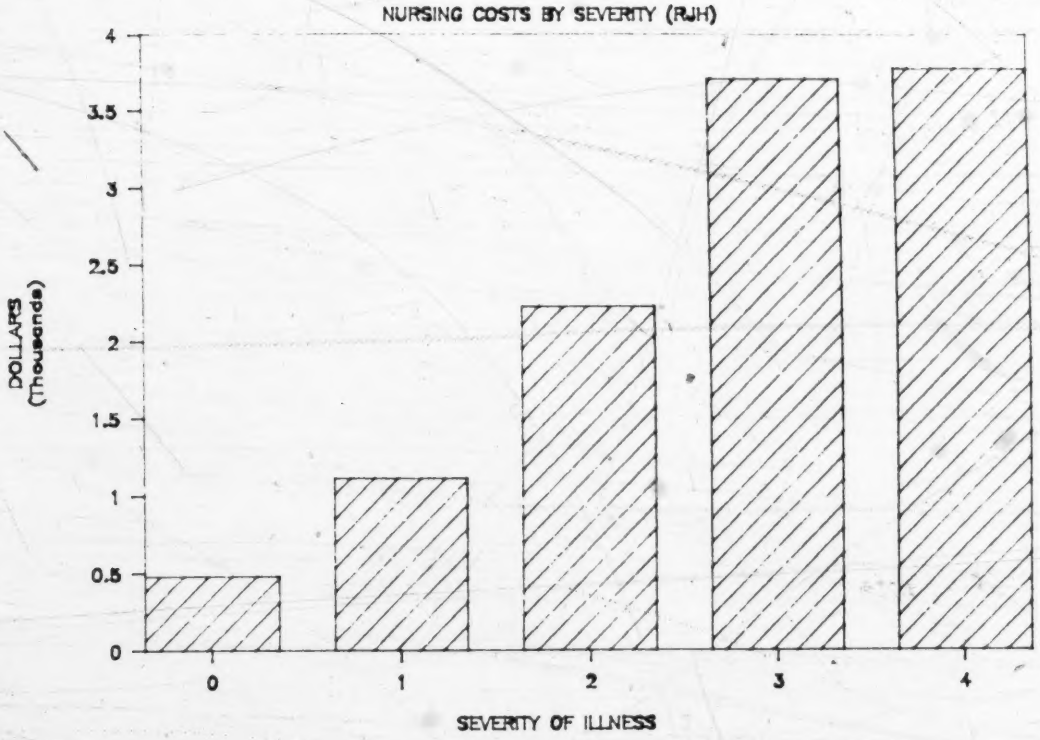
DRG	RJH	VGH
014	$133.46	$123.92
143	117.38	83.91
243	75.56	58.50
209	114.05	89.23
219	68.43	66.69
337	68.82	82.03
468	87.10	88.03

TABLE 4

Average Nursing Cost(per Admission (by Severity)

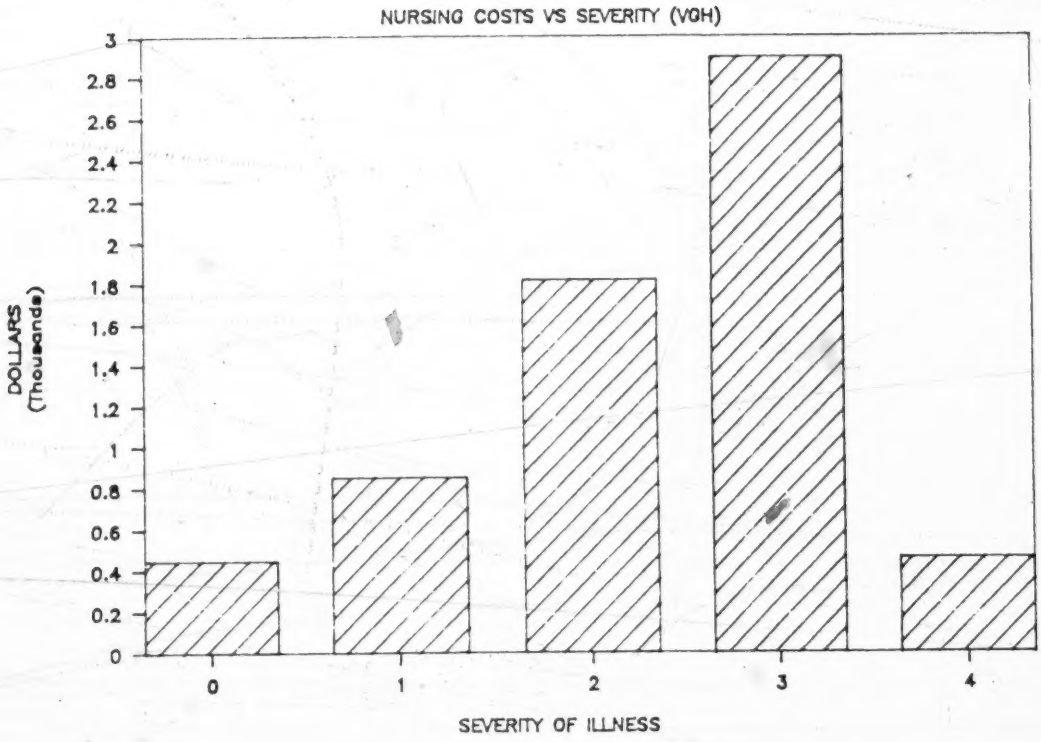
Severity	RJH	N	VGH	N
0	$ 483.99	470	$ 450.18	458
1	1114.00	252	854.52	252
2	2224.91	154	1815.15	106
3	3709.88	56	2900.46	26
4	3779.00	1	460.50	2

FIGURE 1



Please note that the sample size for severity level 4 is less than 1% of all patients.

FIGURE 2



Please note that the sampl size for severity level 4 is less than 1% of all patients.

TABLE 5

Average Nursing Cost per Admission (by Severity)

DRG 014

Severity	RJH			N	VGH			N
0	$1210.52	±	1822.14	27	$649.50	±	585.47	10
1	2643.62	±	2741.56	29	1641.78	±	2147.66	18
2	2618.99	±	2591.80	96	2545.53	±	2778.15	51
3	3987.00	±	3599.08	45	2864.13	±	2956.83	24
4	3779.00			1	460.50	±	290.62	4
F	4.36				2.01			
P	<0.01				N.S.			

TABLE 6

Average Nursing Cost per Admission (by Severity)

(DRG 143)

Severity	RJH	N	VGH	N
0	$ 255.39 ± 156.68	36	$ 297.79 ± 373.69	42
1	459.87 ± 564.81	31	362.94 ± 284.50	32
2	461.27 ± 247.68	11	410.86 ± 297.03	14
F	2.76		0.73	
P	N.S.		N.S.	

TABLE 7

Average Nursing Costper Admission (by Severity)

(DRG 243)

Severity	RJH	N	VGH	N
0	$ 276.73 ± 516.98	169	$ 235.01 ± 351.65	159
1	$ 510.05 ± 859.01	43	357.12 ± 375.20	41
2	819.70 ± 601.09	10	$ 686.10 ± 682.78	10
3	5315.11	1	1480.19	1
F	26.55		8.57	
P	<0.01		<0.01	

TABLE 8

Average Nursing Costs per Admission (by Severity)

(DRG 219)

Severity	RJH	N	VGH	N
0	$ 375.93 ± 197.00	15	$ 352.67 ± 326.76	27
1	415.22 ± 313.17	9	$ 531.39 ± 424.26	36
2	467.85	1	$ 654.33 ± 553.74	2
F	--		1.97	
P	N.S.		N.S.	

TABLE 9

Average Nursing Cost per Admission (by Severity)

(DRG 209)

Severity	RJH	N	VGH	N
0	$ 795.59 ± 415.49	92	$754.92 ± 572.00	130
1	1485.37 ± 1245.51	62	$1684.27 ± 2897.85	52
2	2145.81 ± 1206.61	16	$2182.59 ± 1839.11	7
3	1996.19	1	$ 5193.39	1
F	14.72		7.35	
P	<0.01		<0.01	

TABLE 10

Average Nursing Cost per Admisssion (by Severity)

(DRG 337)

Severity	RJH	N	VGH	N
0	$ 387.54 ± 151.97	84	$ 458.14 ± 190.67	110
1	533.17 ± 295.41	56	578.86 ± 429.83	60
2	706.85 ± 140.82	5	691.11 ± 561.35	5
3	300.19	1		
F	4.89		4.25	
P	<0.01		<0.025	

TABLE 11

Average Nursing Cost per Admission (by Severity)

(DRG 468)

Severity	RJH	H	VGH	N
0	$ 827.48 ± 744.39	21	$ 258.91 ± 156.43	6
1	2225.00 ± 2600.99	18	1187.41 ± 1033.95	17
2	2640.47 ± 2168.11	15	1829.56 ± 1691.81	16
3	2590.88 ± 2011.45	8	--	-
	F 3.59		3.33	
	P <0.025		<0.05	

The results of the coefficient of variation analysis are summarised in Table 12. In this Table, the variation in nursing costs for all patients in a DRG (represented by CV) is compared with the variation within the set of severity-adjusted DRGs (represented by WCV). The computation has been done by DRG.

A comparison of the relative use of nursing resources by patients in the seven DRGs is contained in Table 13. For this, "low" severity includes all patients at MedisGroups levels 0 and 1, and "high" severity, levels 2, 3 and 4. The percentage of patients in each of these categories (by DRG) and the percentage of nursing costs due to these patients are tabulated, eg. 72% of patients in DRG 014 are in the high severity group and cause 81% of costs. Finally, this aggregation of severity groups is used to get an average cost of treating a low severity patient as compared to a high severity patient. These costs by DRG are shown in Table 14.

4.3 Variations between Hospitals

The differences in costs of nursing care delivered to the patients in this study are displayed in Table 15. No clear pattern is evident with these average nursing costs per admission. In DRG 014, for example, the average RJH cost is about 22% greater than in VGH; however, for DRG 337, VGH is about 16% costlier. The average severity levels of patients by DRG are also tabulated.

TABLE 12

Coefficient of Variation (Original vs. Weighted Average)

DRG	014	143	243	209	219	337	468
			RJH				
CV*	105	108	188	84	67	70	130
WCV**	107	86	176	64	59	60	105
			VGH				
CV*	130	124	141	154	86	43	96
WCV**	113	109	137	100	85	38	82

* CV - Coefficient of Variation (original) for all patients in the DRG

** WCV - Coefficient of Variation (weighted Average) of the set of severity-adjusted subgroups in the DRG

TABLE 13

Nursing Costs Comparison (Low vs. High Severity)

	Low Severity		High Severity	
DRG	% of patients	% of costs	% of patients	% of costs
014	28	19	72	81
143	85	82	15	18
243	95	85	5	15
209	93	86	7	14
219	96	94	4	6
337	95	95	3	5
468	61	47	39	53

TABLE 14

Average Nursing Costs (Low vs High Severity) per patient

DRG	Low Severity	High Severity
243	$ 292.98	$ 993.27
143	339.30	433.04
219	437.10	607.75
337	476.93	662.73
209	1044.67	2272.08
468	1297.82	2297.62
014	1730.90	2895.43

TABLE 15

Inter-hospital comparison

Nursing costs ($\$_{ave}$) and Average Severity ($S_{ave}$)

DRG	RJH			VGH		
	$\$_{ave}$	S_{ave}	N	$\$_{ave}$	S_{ave}	N
143	$365.69	0.68	78	$339.47	0.68	88
243	368.66	0.30	223	286.01	0.30	211
219	393.62	0.44	25	463.83	0.64	66
337	445.76	0.41	176	529.08	0.46	145
209	1179.04	0.57	171	1185.23	0.36	190
468	1899.37	1.16	62	1041.08	1.00	49
014	2747.30	1.82	198	2243.13	1.90	105

CHAPTER 5

DISCUSSION

5.1 Variations between DRGs

Nursing cost variation between DRGs which have been demonstrated in Chapter 4 bear out what other researchers have found. Mitchell et al (1984) found wide ranges in labour hours as well as in costs. Variances in time (and by implication, costs) were also reported by Halloran and Halloran (1985). Fosbinder (1986) established that there was a six-fold range in average costs. This is similar to the present study, in which a seven-fold range has been shown.

The argument could be made that such large variations between DRGs could be due partly to the differences in LOS. The DRG system in fact is based partly on differences in LOS. To examine this, the average nursing cost per patient day was tabulated (Table 3). The results show that there are still variations, implying varying nursing intensity needs for patients in different DRGs. This is similar to the per diem variations reported by Mowry and Korpman (1985).

The present study confirms results of other studies which indicate that the DRG system is not adequately suited to account for nursing needs, and therefore nursing costs.

5.2 Variations within DRGs

Although the DRGs were developed originally as a means of fair reimbursement of hospitals for resource utilisation, it has become apparent that the system is not altogether fair. Even within individual DRGs, the literature shows that there are wide variances in LOS and costs; Chapter 2 has made reference to this work. The figures contained in Table 2 show this quite clearly as well, with large standard deviations being the rule rather than the exception. A number of reasons have been cited for this heterogeneity within a DRG. One of these is the patient's severity of illness. Not all patients in a DRG that are admitted to a hospital are equally "severe" (regardless of what criteria are used, for the moment). Consequently they could, and in fact do, have different needs for care.

The present study shows that one possible reason for the within-DRG variations is illness severity. In addition, the results show that in general, there is a correlation between severity and nursing costs. Table 4 contains mean nursing costs by MedisGroups severity. The data has been aggregated over the seven DRGs. A trend, at least in the 1774 admissions classified as level 0 to 3, is clear from this. If an extrapolation from this group of seven DRGs to all admissions is possible at all, then it would seem that costs for nursing required increase with increased medical severity, at least in a large part of the population (excluding severity group 4). Severity group 4 may at first sight appear to violate this trend; however, there are reasons for this. Firstly,

the number of patients in this group is extremely small, six, which is less than one-third of 1% of the sample. Each individual patient's cost data will therefore have major impact on the group mean. Secondly, three of the six very severely ill patients died during the hospitalisation, and had significantly lower LOS than the three survivors. This finding is similar to that of Iezzoni, Ash, Cobb and Moskowitz (1988).

Tables 5 to 11 contain a comparison of average nursing costs per admission (by DRG) between different levels of severity. The data has been separated by hospital. Since patients who in the course of hospitalisation underwent a stay in an ICU were excluded from this study, there are small numbers in the higher severity levels. Still, there are significant differences in some DRGs (243, 209, 337,014 and 468) as evidenced by the F-values. The differences are not significant for the other two DRGs.

Horn, Sharkey and Bertram (1983), using the original manual severity index, employed an analysis of the coefficient of variation to assess the effect of using severity to subgroup patients within DRGs. A similar analysis has been discussed in Chapter 3 and the results presented in Table 12. Two things are revealed in this table. Firstly, there are large variances within individual DRGs as indicated by large CVs. The variances themselves vary from DRG to DRG. This point has already been noted. Secondly, in 19 of the 21 entries in the table, grouping of patients by severity within individual DRGs reduces overall

variance, ie. WCV is less than CV. Again the amount of reduction is not uniform. This implies that perhaps in some diagnostic categories severity could be a good predictor of nursing costs, while it is not so in others.

The variance in labour costs for nursing within DRGs can be demonstrated in other ways. Patients in higher severity groups utilise disproportionately more in the way of nursing resourses than those of lower severity. Table 13 shows this. In all DRGs, the percentage of nursing costs exceeds the percentage of patients in the "High Severity" group. If there is a change in a hospital's case-mix from lower to higher severity, it will require significantly more resources (Table 14).

5.3 Variations between hospitals

The trends discussed in Sections 4.2 and 4.3, both across DRGs and within individual DRGs are relatively similar when each hospital is considered separately, and when they are combined. However, just as no two patients are exactly identical, no two hospitals are, either. Physicians could be different, the physical layout will definitely be different, and in the case of nursing, the labour mix could be different. These could cause different costs for patients in the same DRG. In addition, it is possible that different hospitals, in general, could have different severity mixes even in the same DRG. To determine whether such differences do exist, an interhospital comparison was made. Table 15 contains some of the results.

The major differences in costs between the hospitals appear to be for the patients who are sicker. For S_{ave} less than 1, the differences are not large. For S_{ave} greater than 1, however, the average RJH costs are nearly 40% higher than for VGH. The data does not provide any clear reason why this is so.

CHAPTER 6

CONCLUSIONS

Three questions were addressed in this thesis project. They are concerned with variations in the costs of nursing care between DRGs, within DRGs and between the two hospitals included in the study. The data that forms the basis of the study demonstrates that both per-admission and per-day costs vary from DRG to DRG. This is a finding that is consistent with the literature. The average daily cost variations show that it is not merely LOS (by DRG) that drives nursing costs. Further, on a DRG-by-DRG basis, the cost trends per admission for nursing do not exactly reflect the actual published DRG weights. However, when grouped into two sets based on costs per admission, a relationship can be demonstrated with DRG weights. In the "low" group (DRGs 014, 243, 337 and 219) the average costs per admission are all lower than in the "high" group (DRGs 014, 468, 209). This reflects DRG weights which are all lower in the "low" group than in the "high" group.

A flat, per-diem cost for nursing across all DRGs clearly does not take into account the varying nursing intensities that are actually needed to provide appropriate levels of care. This study shows that in some diagnostic categories, the cost of providing nursing care will be higher than in others. Hospital costs will therefore vary, depending on the DRG mix.

There is a similar source of variation within individual DRGs as

well. This is due in part to the severity of the patient's illness. The analysis here shows that there are trends in nursing costs, related to medical severity. In all 7 DRGs, nursing costs increase monotonically with severity group from 0 to 3. As well an ANOVA showed significant differences between severity levels within five of the seven DRGs. The group in severity level 4 included patients who died early in the hospitalisation, and hence had lesser costs.

Previous work has not clearly established that medical severity is necessarily related to nursing needs. The present study demonstrates that it is at least one factor driving nursing costs. It also demonstrates some reduction in variance or spread in nursing costs when severity is used to subgroup patients of a given DRG. Nursing intensity varies within and between DRGs and must be considered in any consideration of hospital costs.

The conclusions of the study are limited by the nature and breadth of the data available. The study has focused on total nursing costs, as defined in Chapter 3. As a result, no comment can be made about the relationship between actual direct nursing needs of patients in different DRG categories. As well, it is not apparent from the data what causes the variation between hospitals in costs by DRG. However, despite this, the general conclusion, that severity of illness, measured by MedisGroups which is based on a medical model is a factor in determining nursing costs, has been validated in this study. Although there are claims that the

variations in nursing intensity needed due to severity may not have a major impact on a hospital's reimbursement (Cromwell J and Price KF, 1988), further study on the actual impact of these nursing costs variations on total hospital costs would be important.

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